2.—TWO NEW BERYLLIUM MINERALS FROM LONDONDERRY.

By

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An examination of a specimen of brown cassiterite submitted by the Government Geologist from the feldspar quarry at Londonderry showed the presence of a dense compact mineral occurring in thin layers throughout the cassiterite. It could not be readily identified by optical means and there was insufficient material available for chemical tests.

At the authors' request for more material, Mr. H. A. Ellis, Government Geologist, visited the quarry and with the manager Mr. Duplex collected and forwarded more specimens of cassiterite-bearing pegmatite. Several large fragments were received containing wedge shaped pieces of cassiterite up to $3\frac{1}{2}$in. long and 2in. across the base associated with quartz beryl and albite. The unidentified mineral called "A" occurred in thin layers 2 or 3 square inches in area lying on the cassiterite or closely adjacent to it and is the first mineral described in this paper.

Duplex drew Ellis' attention to another mineral associated with "A" in the specimens. It occurred as well crystallised colourless plates and fibrous prismatic radiating masses and is the second mineral described, called "B." Investigation has shown them both to be beryllium minerals new to Western Australia.

The Londonderry feldspar quarry is situated 13 miles S.S.W. by road from Coolgardie. Although a considerable quantity of pegmatite has been removed over a number of years while mining microcline, it was only recently that these new minerals were recognised. They occurred in a columbite-cassiterite band of mineralisation in the east wall in a second lower bench in the quarry.

"A" BOWLEYITE.

The first observed occurrence of this mineral showed it to occur as brownish white compact layers closely associated with cassiterite. A microscopic examination showed it to be intimately associated with fine granular quartz and a few scattered grains of cassiterite. The particles appeared to be uniform in character and were seen as colourless, flat plates, distinctly micaceous in habit, with weak birefringence, sometimes appearing isotropic.

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In other later specimens it was seen to occur mainly in narrow narrow layers lying between quartz and wedge shaped masses of granular cassiterite and in small very thin layers throughout the cassiterite. It also occurred in massive form and as a lens shaped vesicular mass near to, but not in contact with, the cassiterite. These latter occurrences were associated with quartz to a much less extent and in some cases only a few grains were noticed under the microscope.

In all the samples of pegmatite examined, the similarity of appearance and the constant optical properties of the mineral indicated a uniform composition. It is infusible in the bunsen flame and when finely ground is decomposed by fuming sulphuric acid, with the separation of gelatinous silica.

The first sample for analysis was prepared from layers of the mineral as it was found *in situ* in the first observed occurrence. A microscopic examination of the powder showed it to contain a considerable amount of free quartz. This was determined by decomposing the mineral with fuming sulphuric acid and treating the residue with warm Lunge's solution to remove the separated silica. The free silica 34.27%, the small amount of SnO_2 present as cassiterite 0.13%, and moisture 0.20%, were deducted from the analysis and the balance recalculated giving the following figures:

Analysis	%	Mols.	
SiO_2	32.22	5365	
Al_2O_3	35.58	3490	
Fe_2O_3	nil	—	
BeO	8.05	3217	
MnO	nil	—	
MgO	nil	—	
CaO	15.35	2737	
Na_2O	.55	89	} 972
K_2O	.09	10	
Li_2O	2.61	873	
Ign. Loss	5.80	3219*	
TiO_2	nil	—	
P_2O_5	nil	—	
Cl	nil	—	
F	nil	—	
CO_2	nil	—	
Total	100.25		

S.G. Clean mineral 3.02

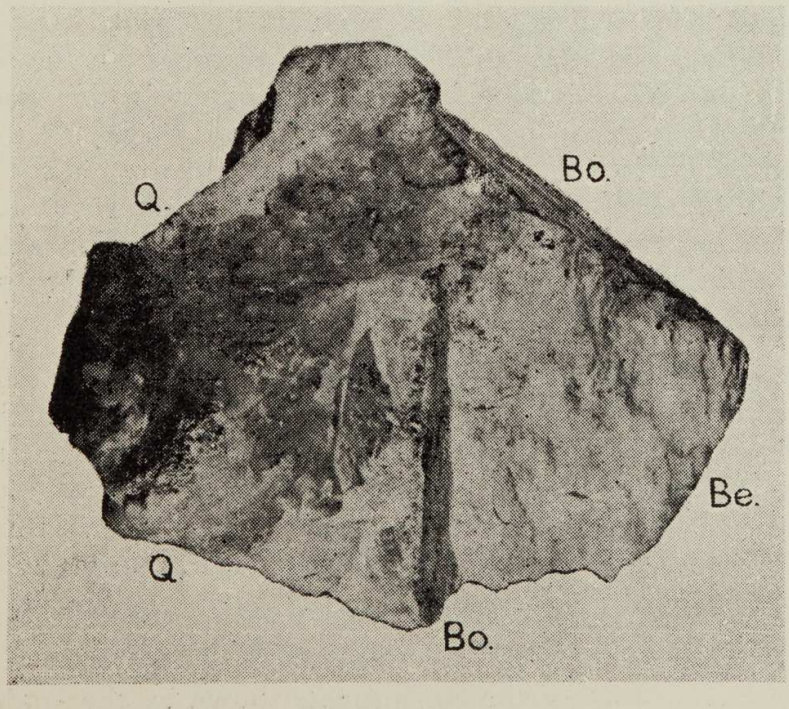
* Combined H_2O. Analyst: J. D. Hayton.

At this stage of the investigation the authors visited the quarry to study the manner of occurrence and distribution and to collect further type specimens.

Unfortunately all the cassiterite bearing pegmatite had been removed and until further mining is done will not be exposed again. However an examination of spoil dumps from a nearby band of mineralisation containing columbite, yielded specimens of material which proved on examination in the laboratory to be the same mineral. Some good specimens were obtained which gave sufficient clean mineral for further examination. The optical and physical properties were the same as those obtained from the previous specimens examined.

In some specimens the mineral occurred as flat wedge shaped plates several square inches in area up to $\frac{1}{8}$in. in thickness at the juncture of milky beryl and quartz and in fractures in the beryl itself (text fig. 1). It has quite definite lines of demarcation and does not appear to be an alteration product. It was also noticed as thin layers with thin plates of quartz, the surfaces of which formed a knife edge up to $1\frac{1}{2}$in. long and in the centre of which is mineral "B" enclosing small idiomorphic crystals of quartz up to $\frac{1}{4}$in. long. In other specimens it occurred as wedge shaped masses up to 2in. in length and 1in. across the base in pearly albite, beryl and quartz associated with small included patches of quartz and a little mineral "B."

Clean fragments of the mineral from one of the last specimens described free from quartz etc. were carefully selected by hand and lightly crushed to pass a 60 mesh screen. Any fines passing a 90 mesh screen were rejected. This −60 +90 product consisting of platy aggregates was then separated in bromoform solution, S.G. 2.84 to remove any small amounts of quartz, beryl, albite or mineral "B". The



Text fig. 1.—Bowleyite (Bo) at the junction of Beryl (Be) and Quartz (Q.). One-half natural size.

Photo. by S. E. Terrill.

heavy fraction from this separation was again separated in a solution S.G. 2.93 the heavy fraction of which being proved clean by microscopic examination was crushed to pass a 90 mesh screen for analysis.

Analysis	Moisture free	
	%	Mols.
SiO_2	33.37	5556
Al_2O_3	36.24	3555
BeO	7.30	2918
CaO	14.42	2571
FeO	.17	24
MnO	trace	—
MgO	.04	10
Li_2O	2.39	800
Na_2O	.29	45
K_2O	.04	4
Ign. Loss	5.72	3175*
TiO_2	nil	—
Total	99.98	
	S.G. 3.03	

*Combined H_2O.

Analyst: H. P. Rowledge, J. D. Hayton.

The first analysis was carried out on selected fragments of the mineral as it occurred *in situ* without removing any impurities. The second analysis was done on the pure mineral after removing any small amounts of quartz, albite, beryl and mineral "B" present as described above. Both analyses give figures which are in reasonable agreement but the figures in the first were obtained by calculation after eliminating the quartz, the determination of which is not an exact method owing to the small possible attack of Lunge's solution on the quartz and the presence of any small amounts of other mineral unattacked by sulphuric acid. For the purpose of determining the true molecular constitution the figures from the second analysis must be taken as they represent the values on a clean sample.

The method adopted for the separation of beryllium and aluminium was based on the 8 hydroxyquinoline method described by Kolthoff and Sandell with later modifications by other workers and further modified by C. R. Le Mesurier at the Government Chemical Laboratories, Western Australia. The final method adopted has been successfully applied in the analysis of beryl in this laboratory and has been used in all analyses of beryl in this laboratory. It has been used in all analyses recorded in this paper.

The molecular ratios of the constituents shown by the analysis are:

SiO_2	Al_2O_3	BeO	Ca(Fe,Mg)O	$Li(Na)_2O$	H_2O
1	.64	.53	.47	.15	.57
			1.00		

The alkali molecules are in minor proportions and the authors are of the opinion that they are not an essential part of the constitution but are small amounts in excess in the mineralising solution over that required for the crystallisation of petalite and have been occluded in the mineral which is considered to be the last product of solidification in the process of differentiation.

Beryllium oxide is assumed to be isomorphously replaceable with calcium oxide and eliminating the alkalies the principal constituents are in the ratio of $3[BeCa(FeMg)]O.\ 2Al_2O_3.\ 3SiO_2.\ 2H_2O$, with the ratio of BeO:CaO approximating 1 : 1.

The formula for this mineral would thus be $3[(BeCa)O].\ 2Al_2O_3.\ 3SiO_2.\ 2H_2O + n\ Li(Na)_2O$.

An optical examination of the powder showed it to consist of colourless micaceous plates normal to Bxa or nearly so. The maximum and minimum refractive indices of the plates on the flat lie between 1.65 and 1.66, with very weak birefringence. On edge the maximum refractive index was greater than, but near to 1.66, the birefringence being about that for quartz. The mineral is biaxial negative with 2E small.

Conclusions.

The predominant form in which this mineral occurs is in brownish white, flat compact waxy looking layers and in wedge shaped micaceous aggregates associated with quartz, beryl, albite and mineral "B" in the columbite and cassiterite bearing bands of mineralisation in the pegmatite.

In different parts of the east wall of the quarry where these occur, are individual masses of minerals containing the elements found in the mineral with the exception of lime. Lithium and aluminium occur as petalite, beryllium and aluminium as beryl. The feldspars are albite and microcline, the soda and potash varieties respectively. It is interesting to note that no lime minerals other than the mineral under discussion have yet been recognised in this pegmatite.

The method of occurrence of mineral "A" suggests that it is the last product of crystallisation of the mineralising solution. It is different in chemical composition, optical and physical characteristics from any known mineral and is therefore a new species for which the name *Bowleyite* is given in honour of Mr. H. Bowley, Director of Chemical Laboratories and Government Mineralogist of Western Australia.

"B" DUPLEXITE.

Mineral "B" occurs as fan shaped crystalline aggregates up to ½in. in radius sometimes forming almost complete rosettes. It is pearly white and lustrous, extremely brittle with pronounced cleavage in two directions. When crushed it breaks into long and short rectangular fragments. Some of these fragments show very weak birefringence, sometimes appearing isotropic, while the majority show moderate to weak birefringence and have a small extinction angle (2–5°). The splinters

are readily fusible in the bunsen flame. The powder is insoluble in strong hydrochloric acid or fuming sulphuric acid.

The fragments for the first analysis were carefully selected by hand, crushed and cleaned by separation in known S.G. solutions. Bromoform S.G. 2.84 was first used to separate any heavy minerals including mineral "A". The light fraction was then separated in a bromoform-acetone mixture S.G. 2.67 to separate any quartz or possible kaolin. A microscopic examination of this heavier fraction showed some slight alteration of mineral "B" and the absence of quartz. It was again separated in solution S.G. 2.63. The coarser particles of this heavier fraction were again lightly crushed and separated as before. The final product S.G. $> 2.63 < 2.75$ was examined and crushed through a 90 mesh screen for analysis.

The second sample was prepared from another specimen in which the mineral was more plentiful and clean. A number of small fragments were carefully selected and crushed. The first powdery crushings –90 mesh were discarded as they appeared more cloudy than subsequent fractions. The remainder was crushed through a 90 mesh screen and used for the second analysis.

Analysis.	1. %	Mols.	2. %	Mols.
SiO_2	58.92	9810	59.13	9845
Al_2O_3	6.88	675	7.00	687
Fe_2O_3	.07	4	nil	—
BeO	7.72	3085	7.14	2854
CaO	23.26	4148	23.90	4262
MnO	.01	1	.01	1
MgO	.13	32	.05	12
Na_2O	.44	71	.10	16
K_2O	.04	4	nil	—
Li_2O	trace	—	nil	—
Ign.. Loss	n.d.	—	2.46*	1366
H_2O+	2.41	1337	n.d.	
H_2O-	.06		.06	
TiO_2	nil		nil	
P_2O_5	nil		nil	
SnO_2	nil		nil	
F	nil		nil	
Cl	n.d.		.02	
CO_2	n.d.		.03	
C	n.d.		.11	
Total	99.94		100.01	

S.G., 2.71.

Analyst: J. D. Hayton.

*Ignition Loss, taken as combined water, after deducting .11C, .02 Cl, .03 CO_2, .06H_2O.

The molecular ratios of the principal constituents are as follows:

	SiO_2	BeO	Ca(MgMn)O	Al_2O_3	H_2O
Anal. 1	1	.30	.43	.07	.14
" 2	1	.29	.43	.07	.14

The formula for this mineral would thus be—

$$Al_2O_3.4BeO.6CaO.14SiO_2.2H_2O.$$

A microscopic examination of the powder showed it to have the following optical properties:

Ng 1.593, Nm 1.584, Np 1.582 Na, Ng–Np = .011.

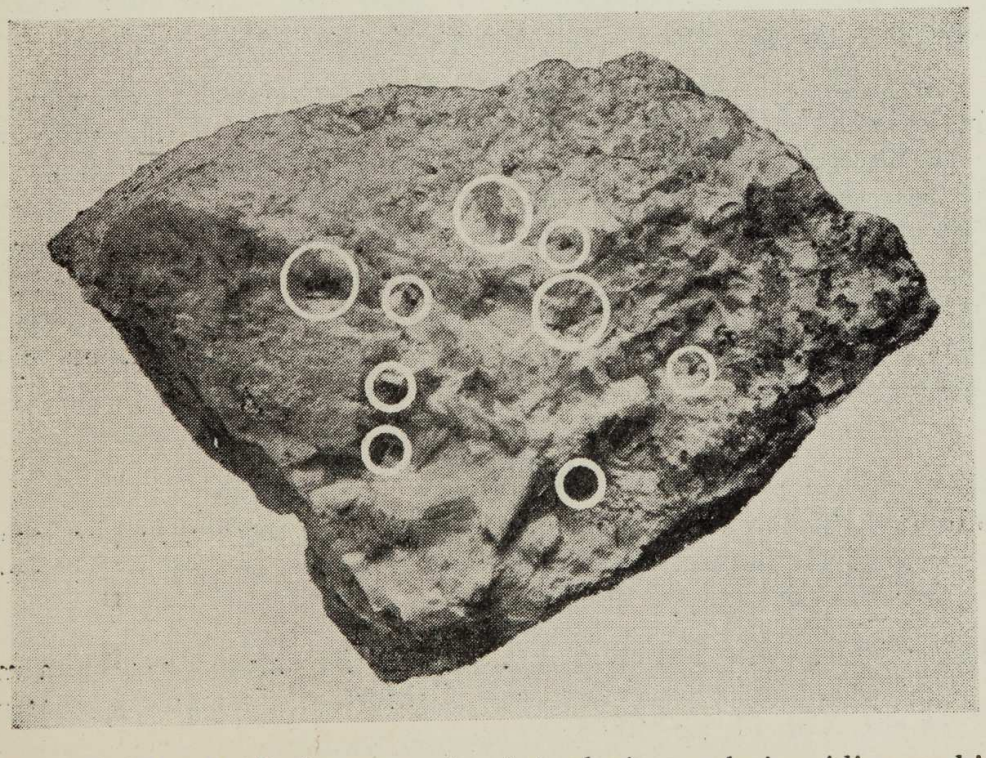
Biaxial +, 2V approx. 22°.

Elongation Negative. Extinction Angle 2–5°.

Conclusions.

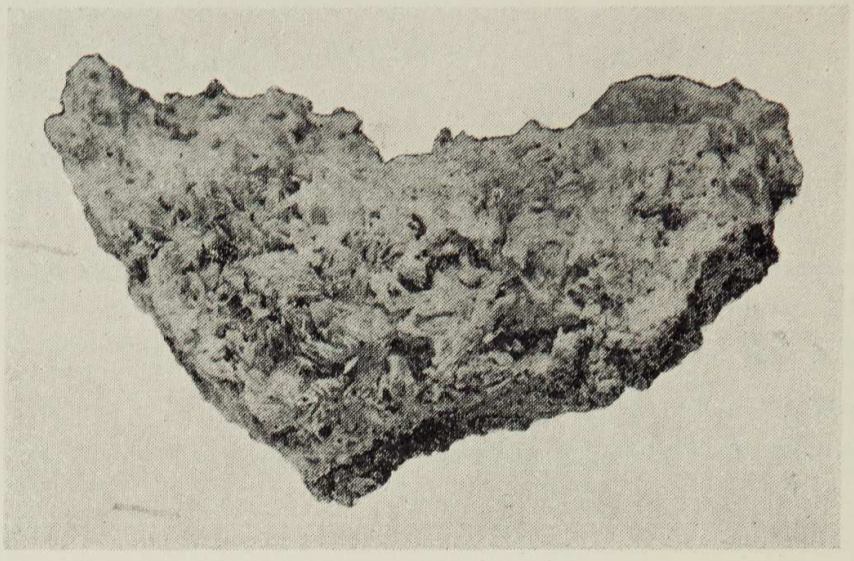
The first specimen examined showed the mineral as occurring in fibrous radiating crystalline aggregates forming numerous rosettes over an area of several square inches abutting mineral "A" and associated with quartz, albite and beryl.

Other specimens showed it as well crystallised squarish plates penetrating a cavity surrounded by radiating fibrous and platy masses bordered by a rectangular plate of quartz. Embedded in the mineral were smaller plates of quartz. The remainder of the specimen consisted of partly altered milky beryl. On one edge was a small wedge of cassiterite and in places thin films of pucherite. Another specimen showed it as



Text fig. 2.—Radiating crystals of duplexite enclosing idiomorphic quartz crystals (in circles). Two-thirds natural size.

Photo. by S. E. Terrill.



Text fig. 3.—Platy crystal aggregates of duplexite in beryl, quartz, albite, pegmatite. Two-thirds natural size.

Photo. by S. E. Terrill.

typical radiating masses over an area of 3 or 4 square inches in which were embedded small well developed quartz crystals the largest being approx. $\frac{1}{2}$in. long. (text fig. 2).

The manner of occurrence suggests that the mineral was one of the last to crystallise from the mineralising solution penetrating the pegmatite and that it has crystallised at the same time as or later than the idiomorphic quartz crystals, but before Mineral "A."

In optical properties it closely resembles bavenite as described by Schaller and Fairchild which contains 2.67% BeO with a molecular ratio for Al_2O_3:BeO of 1:1. This ratio was also obtained by Grill in a new analysis of bavenite from Baveno. Mineral "B" however, contains 7.14% BeO with a molecular ratio for Al_2O_3:BeO of 1:4. No mineral is yet known with the composition as shown by the analysis and it is a new species for which the name *Duplexite* is suggested, after the manager of the quarry, Mr. S. Duplex, who first drew attention to this mineral.

LITERATURE.

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